

Washington Fuel Cell Education Project Curriculum aligned to California State Science Education Standards

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Investigation	Description	CA Standard Focus
#1: Observing, Predicting, and Questioning using the Apparatus as a Focus	Students explore the fuel cell device in an open ended introduction activity. Key to this developmental activity is the connection between our <u>observations</u> and our <u>predicted</u> understanding of the system.	<p>“Formulate explanations using logic and evidence.” Chapter 5, Investigation and Experimentation, 1.d. p. 279</p> <p>“Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent... and that the theory is sometimes wrong” Chapter 5, Investigation and Experimentation, 1.n. p. 279</p>
#2: Solar Panel Orientation	Students provide graphical evidence for the correct angle of the solar panel and light while becoming more familiar with the equipment in the kit.	<p>“Formulate explanations using logic and evidence.” Chapter 5, Investigation and Experimentation, 1.d. p. 279</p> <p>“Students know waves carry energy from one place to another.” Chapter 5, Physics, 4.a., p. 172</p> <p>“Select and use appropriate tools and technology...to perform tests, collect data, analyze relationships, and display data.” Chapter 5, Investigation and Experimentation, 1.a., p. 278 <i>and</i> Chapter 4, Grade Seven: Focus on Life Sciences, 7.a. p. 124</p> <p>“Construct appropriate graphs from data and develop quantitative statements about the relationships between variables.” Chapter 4, Grade Eight: Focus on Physical Sciences, 9.e. p. 150</p>

#3: Simple Electrolysis	Students perform simple electrolysis to demonstrate that water forms into gas when electricity flows through it.	<p>“Students know that compounds are formed by combining two or more different elements and that compounds have properties that are different from their constituent elements.” Chapter 4, Grade Eight: Focus on Physical Sciences, 3.b., p. 134</p> <p>“Students know how to describe the dissolving process at the molecular level by using the concept of random molecular motion.” Chapter 5, Chemistry, 6.b. p. 204</p> <p>“Students know salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.” Chapter 5, Chemistry, 2.c. p. 192</p>
#4: Understanding Electrolysis	Students collect the products of an electrolysis reaction and test their properties to determine what they are.	<p>“Students know that compounds are formed by combining two or more different elements and that compounds have properties that are different from their constituent elements.” Chapter 4, Grade Eight: Focus on Physical Sciences, 3.b., p. 134</p> <p>“Students know atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.” Chapter 5, Chemistry, 2.a. p 191</p>
#5: Hydrogen Power	Students measure the electrical power produced from hydrogen in a PEM fuel cell.	<p>“Students know how to apply the concepts of electrical...potential energy to solve problems involving conservation of energy.” Chapter 5, Physics, 5.o. p.183</p> <p>“Identify and communicate sources of unavoidable experimental error” Chapter 5, Investigation and Experimentation, 1.b. p. 278</p>
#6: Hydrogen Power in Motion	Students compare the actual power produced from the PEM fuel cell to the power output of driving the car.	<p>“Students know ...that all real engines lose some heat to their surroundings.” Chapter 5, Physics, 3.g. p. 171</p> <p>“Students know how to apply the concepts of electrical...potential energy to solve problems involving conservation of energy.” Chapter 5, Physics, 5.o. p.183</p>

#7: Energy Efficiency	Students measure the power that goes in to electrolyzing water in a PEM fuel cell and compare that to the power that comes out.	<p>“Students know how to solve problems involving Ohm’s law.” Chapter 5, Physics, 5.b. p. 178</p> <p>“Students know how to solve problems involving heat flow, work and efficiency in a(n)...engine and know that all real engines lose some heat to their surroundings.” Chapter 5, Physics, 3.g. p. 171</p> <p>“Students know how to solve problems involving conservation of energy in simple systems with various sources of potential energy” Chapter 5, Physics, 2.h. p. 165</p>
#8: Extending our Knowledge	Students prepare an extension investigation in some aspect of hydrogen technology demonstrating their knowledge of hydrogen’s potential as a fuel source.	<p>“Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings.” Chapter 5, Investigation and Experimentation, 1.m. p 279</p>